Pacific Regional Biomass Energy Program
Montana Project Summary Sheet

1. **Title:** ***Pilot Demonstration of Biodiesel in Tourism-Related Transportation: A Truck in the Park***

2. **Brief Description:** DEQ spearheaded a project to demonstrate biodiesel use in Yellowstone National Park (YNP). With visitation increasing yearly, there was a need for more efficient transportation, such as buses, and reduced pollution, odors, and smoke caused by tourism transportation. Rapeseed ethyl ester (REE) could be at least part of the remedy for pollution generated by motor vehicles in Yellowstone. REE is produced from rapeseed oil reacted with ethanol that is made from potato waste generated by the food processing industry. Yellowstone offers an opportunity to demonstrate this low emission, biodegradable fuel in an environmentally sensitive, cold climate area. Such areas may prove to be a near-term niche market for this and similar bio-based fuels.

3. **Grantee:** Montana Department of Environmental Quality, Air, Energy, and Pollution Prevention Bureau, 1100 North Last Chance Gulch, P. O. Box 200901, Helena, MT 59620-0901.
   Contact: Howard E. Haines, Bioenergy Program Manager, Phone 406-841-5252, FAX 406-841-5091, Email hhaines@mt.gov web site http://www.deq.state.mt.us/bioenergy

4. **Project Manager: Jeffrey W. James, Program Manager,** jeffrey.james@hq.doe.gov
   U. S. Department of Energy Seattle Regional Office, 800 Fifth Avenue, Suite 3950, Seattle, WA 98104 Phone 206-553-2079, FAX 206-553-2200 Contract Identification No: **DE-FG51-94R020493**, DEQ Grant. 780006 and EDG- 95-7562

5. **Estimated total cost:** $344,294 DOE **Regional Program Funds: $111,102**
6. **Cost Sharing and Project Partners:** $233,619
   Montana Department of Environmental Quality (DEQ): project design and lead ($53,000)
   U. S. Department of Interior, National Park Service, Yellowstone National Park (NPS), truck equipment, lube oil, fuel storage facilities, canola ethyl ester (CEE) and operator (in-kind) + $35,419
   Wyoming Department of Commerce, Energy Office, emissions testing ($30,000)
   Dodge Truck of Chrysler Corporation [vehicle + technical oversight + in-kind]
   Cummins Engine Company (engine + technical support)
   Cummins Intermountain Distributor, Pocatello ID
   J.R. Simplot Company, Boise, ID (ethanol and catalyst for biodiesel)
   Koch Agricultural Services Company, Great Falls, MT [rapeseed oil + shipping)
   Tractor & Equipment Company (T & E), Billings, Montana [performance testing)
   University of Idaho (UI), Agricultural Engineering Department, (fuel, emissions, performance test analysis, reduced indirect)
   McGreggor Company [biodiesel and feedstock storage]
   University of California, Davis, Environmental Toxicology Department [PAH evaluation]

7. **Expanded Description:** The "Truck in the Park" Project was designed with two purposes: to define a market for biodiesel and to provide data on emissions and performance that could be used by land managers, regulators, and providers of commercial tourism transportation. This project was a first-step to reduce environmental impacts resulting from diesel fuel use in the tourism industry. The Montana Department of Environmental Quality (DEQ, successor to the Department of Natural Resources and Conservation) in cooperation with the National Park Service (**NPS**) and Dodge Truck Division of the Chrysler Corporation operated a 1995 ¾ ton 4x4 diesel truck fueled by 100 percent rapeseed ethyl ester produced by the University of Idaho (**UI**) and private cooperators. Basically, the project placed an unaltered diesel pickup truck into service in

Yellowstone National Park, fueled this truck with 100 percent rapeseed ethyl ester, and monitored performance and emissions. Data were collected to determine the reliability, benefits, and costs of using biodiesel in Yellowstone National Park and the surrounding region. The project included fuel characterization, detailed performance and emissions tests before and after (approximately) 149,408 km (92,838 miles) (using EPA protocols), and other quality control testing to document benefits and costs.

8. **Needs Addressed:** Each year about 3 million people visit Yellowstone National Park. The nearly 900,000 automobiles they use to travel to the Park burn thousands of gallons of fuel and produce tons of air pollution, endangering the clear air and water that people expect to see during their visit to the Park. The air in the Park meets EPA air standards, but not always the visitors' expectations.

With visitation increasing steadily over the last several decades, concern has arisen because of increasing congestion on park roads and the threat of increased pollution. One possible solution is to limit visitation, an option not likely to please the members of the public who may not be able to arrange their visit to the park when there are openings. Limiting visitation also is not favored by park concessionaires or economic interests in communities near Yellowstone.

A more desirable choice is to reduce congestion by encouraging use of high occupancy vehicles, such as buses, and by reducing the amount of pollution produced by each vehicle. One way of doing this is to use fuel that produces less pollution when burned in a conventional diesel engine and has exhaust that is less obnoxious to riders and visitors. Vegetable oil can be processed into a diesel fuel--a biodiesel--that produces less pollution than conventional diesel fuel. Exhaust emissions from these biodiesels smell less unpleasant than conventional diesel exhaust. Conventional diesel fuel also has other characteristics that are undesirable in areas valued for environmental cleanliness. These include toxicity and low biodegradability. Reformulated diesel fuel, intended to meet air emission requirements, is not enough of an improvement to meet the requirements of places like Yellowstone.

Rapeseed ethyl ester (REE) biofuel is a regional development by the University of Idaho (UI) from resources in Montana and Idaho. UI research has shown that REE has increased biodegradability and reduced emissions, odor, and smoke compared to petroleum diesel fuel. REE is at the stage of development where a higher value market, such as this tourist-related application, is the next logical step on the way to commercialization.

9. **Project Objectives:**

- Assist NPS and private industry develop options for reducing environmental degradation without adversely impacting visitation and associated industries;
- Support development of a process to convert food processing waste oil to an environmentally friendly transportation fuel, reducing both dependence upon imported petroleum and the impact on the environment;
- Encourage the development, production, and use of this biofuel within the region;
- Make the first step toward use of low odor, low smoke fuels for tourism leading to use in buses;
- Determine the impacts, benefits, and results from using biodiesel under variable conditions including high elevations and low temperatures; and
- Link the tourism industry with agriculture and energy.

10. Approach: To help commercialize REE, this project: 1. Introduces public and private operators to rapeseed ethyl ester biodiesel as an alternate fuel or blend with regular diesel in environmentally sensitive applications; 2. Develops data to support decisions regarding these fuels in areas with economies based on tourism, such as YNP.
To accomplish this, the National Park Service operates a 1995 Dodge 3/4 ton 4X4 pickup with 5.9 liter Cummins diesel engine, supplied by Dodge Truck. The truck runs under normal operating

conditions as a maintenance inspection vehicle in YNP. No modifications are made to the truck's engine or fuel system. The truck uses 100 percent REE as fuel to develop data for warranty purposes. The demonstration includes normal service and maintenance, and periodic performance and emissions testing to determine if there is any degradation in emissions or performance caused by the fuel. Initial tests were conducted to determine the safety of the fuel and its use relative to the area's wildlife.

This project is in an area that brings humans and wildlife such as bears into close proximity. REE is a vegetable oil derivative that smells similar to oil used in cooking food. The exhaust from a diesel engine fueled by REE smells like a French fry cooker, and may attract bears if the bears in the area connect the scent to a food reward. Attracting bears to vehicles operated by humans should be avoided. A bear attractant analysis was conducted, first to determine if bears are attracted by the scent of biodiesel more so than they are to regular petroleum products, and second to identify if a blend of petroleum diesel with biodiesel reduced the attraction. These data were needed for other users located in environmentally sensitive applications. The demonstration concluded with a detailed emissions test followed by disassembly and inspection of the engine and low pressure fuel systems by Cummins Intermountain Distributor and Bosch.

11. Major Milestones: Term, October 15, 1994 through December 30, 1998

Bear attractant analysis (completed March 1995, report November 1995)
Establish dedicated biodiesel fueling station at YNP (12/5/94)
Vehicle acquisition and preparation (Delivered 2/7/95, markings 3/10/95)
Biodiesel fuel delivery, operational demonstration (University of Idaho from 4/15/95 to 11/96, then to August 2001; Eco-Conscious Fuels, 9/2002-ongoing)
Engine oil analysis (every change)
Engine performance analysis (start, middle, and end of each year, 3/7 & 8/17/95)
Emissions tests (Dynamometer Transient Conditions Emission Tests 3/20-24/95 and 5/26-29/98)
Engine disassembly and inspection, Cummins Engine Company, July 1998.
Reporting, information transfer, presentations, January, 2000.
Expansion to Rideshare and VIP buses and garbage truck fleet: September 2000
Biodiesel incorporated into fuel supply contract with Story Distributing: July 1, 2002
Underground 15,000-gallon B-100 storage tank filled by Story Distributing and Eco-Conscious: September 2002
Use of B-100 or B-20 for all 134 diesel vehicles: September 2002
As of December 17, over 9,000 gallons of biodiesel were used in Yellowstone since September, representing about 43,750 gallons as B-20 and 250 as B-100.

12. Results: (Also see item 11. Major Milestones, above)

Abstract The “Truck in the Park” Project was designed with two purposes: to define a market for biodiesel and to provide data on emissions and performance that could be used by land managers, regulators, and providers of commercial tourism transportation. This project was a first-step to reduce environmental impacts resulting from diesel fuel use in the tourism industry. The project placed an unaltered diesel pickup truck into service in Yellowstone National Park, fueled this truck with 100 percent rapeseed ethyl ester, and monitored performance and emissions. Data were collected to determine the reliability, benefits, and costs of using biodiesel in Yellowstone National Park and the surrounding region. The project included fuel characterization, detailed performance and emissions tests before and after (approximately) 149,408 km (92,838 miles) (using EPA protocols), and other quality control testing to document benefits and costs. The technical data and results of this demonstration are documented in a number of papers listed below. This demonstration showed that:

1. The effects of biodiesel on criteria emissions with and without the catalytic converter were unaffected over the course of time, and that no new compounds are generated in blends of biodiesel with conventional diesel. Air toxics are significantly reduced by increasing the amount of biodiesel in a blend. Overall, hydrocarbons, carbon monoxide were reduced by the use of biodiesel. Oxides of nitrogen were either slightly reduced or unaffected by the use of 100 percent biodiesel, and particulate matter was slightly increased or unaffected;
2. The project developed data for use in modeling air quality so the impacts can be assessed before

a large scale conversion is implemented;
3. Biodiesel or a blend may be the fuel of choice for restricted or poor air dispersion conditions. Tests also showed that the sweet odor of biodiesel exhaust does not attract bears, which was a concern to Park and land management officials.
4. Operation during six Yellowstone winters showed that normal cold-weather diesel modifications were sufficient to enable use of biodiesel in cold weather operations. These included engine coolant, an engine block heater, battery heaters, an external (electric, magnetic) fuel tank heater, and a heating loop to the slip tank. The truck failed to run on only one occasion with a daytime temperature of -38.3 degrees C (-37 degrees F), a time when most things were only running for cover). However, biodiesel in Europe does use a biodegradable cold flow plug point additive for cold climate operations. If a problem occurred, the remedy would be to add No. 1 diesel.
5. The benefits of biodiesel include reduced toxicity, emissions, smoke, unpleasant odor, and increased safety and biodegradability. Two challenges yet remain: availability and cost. For this project, the refueling infrastructure and availability was carried in the bed of the truck, somewhat reducing the truck's usefulness for work. The cost factor was overcome in part by the generous contributions from our many sponsors.

Commonly Asked Questions at Truck Demonstrations:

1. What was modified to enable the truck to use biodiesel? No modifications were made to the engine or low-pressure fuel system—it is stock. A quick disconnect was added to the fuel line for emissions test purposes. An in-bed fuel tank was added to extend the range to about 6,000 miles, also for the trip for emissions testing in Los Angeles, California.
2. What was the mileage?

During Phase 1, the ¾ ton 4X4 Dodge truck averaged 17.3 miles per gallon under load for the first 92,000 miles, or about 1 mile per gallon lower than with conventional diesel. The engine was torn down and inspected to determine that durability was equivalent or better than petroleum diesel fuel.

3. How did the truck perform, including power, compared to petroleum diesel?

A survey of operators reported that the truck performed as any diesel truck, except the odor was better. The truck had regular chassis dynamometer tests that did not show any loss in power over time. Biodiesel has a lower energy content (BTUs per pound) but higher density (more pounds per gallon) than conventional diesel fuel. The loss in peak power was measured to average +/-7 percent.

4. Does the fuel attract bears?

A study conducted by the National Park Service, Montana Department of Environmental Quality, University of Idaho, and Washington State University showed that biodiesel was no greater an attractant for bears than conventional diesel fuel.

5. What was the yield of fuel per acre?

For rapeseed, about 100 gallons per acre, net, and with canola, about 110 gallons per acre.

6. How much did/does biodiesel cost?

For the small batch process used in this project, and including all the ($70,000 of) emissions testing, the fuel would have cost $7.50 per gallon. Commercial scale production would reduce that amount to between $1.35 to $2.00 per gallon. A January 2002 comparison (bid) FOB the blend site (Bozeman, Montana) was $900 per 1,000 gallons for conventional diesel and $944 for B-20, before taxes and delivery. The September 2002 cost with delivery was about $1.30 per gallon (B-100).

7. Where can the public buy biodiesel? Biodiesel can be purchased by the public at Economart, 307 Firehole Ave (and Electric Ave), West Yellowstone, Montana. Distributors can obtain biodiesel from Dan Alexander, Story Distributing, Bozeman, Montana (406-587-0702, storydist@usa.net) or Mike Allen, Allen Oil, in Helena (406 442 7703 mikea@allenoilcompany.com). Today, the National Biodiesel Board lists 55 public biodiesel stations in the US (www.biodiesel.org, buying biodiesel, 800-841-5849). Biodiesel is widely used in Europe since the mid-1990s. B-20 is used in the diesel powered administrative fleet in Yellowstone National Park exclusively since September 2002. Plans are to expand B-20 availability to public service stations in the next several years.

Table 1. Summary of emissions reductions of biodiesel compared to 2D low-sulfur diesel from FTP chassis and engine dynamometer testing

Fuel	2D	B20	B100
Carbon monoxide	100%	-16 to –18%	-35 to –45%
Unburned hydrocarbons	100%	-17 to –23%	-32 to –74%

Particulate matter (PM-10)	100%	-10 to 5%	-50 to 11%
Oxides of nitrogen (NOx)	100%	-4 to –8%	-5 to 9%
Smoke	100%	-47%	-54 to –78%

Status: From February 7, 1995 to March 27, 2003, the National Park Service at Yellowstone National Park operated the first alternate fueled vehicle for 148,000 miles fueled by 100 percent rapeseed ethyl ester biodiesel. The first phase of the project successfully determined management methods to operate in cold climates. During its tenure at Yellowstone, the truck is being used for a number of demonstrations starting with one at the Montana Legislature in May 1995, and including appearances at Bioenergy 96 in Nashville, Tennessee, a number of wildfire schools, National Park Service maintenance meetings in Reno, NV, and Big Sky, MT, and Montana Ethanol Conferences. The initial grant was funded in May 1994 by the Department of Energy, the Montana Department of Natural Resources and Conservation, and others. The project was selected in response to a request for proposal submitted by the Montana Department of Natural Resources and Conservation Energy Division that became part of the Montana Department of Environmental Quality. As a result of this project and the recent Greening of Yellowstone Workshop, the Park Service is expanding the use of biodiesel in its fleet and throughout 20 million acres of the greater Yellowstone region. By October 2000, three MCI buses were converted to run on B20, a blend of 20 percent biodiesel with 80 percent conventional diesel. The buses had been donated to Yellowstone National Park from the Idaho National Engineering and Environmental Laboratory (INEEL) in Idaho Falls for the Rideshare Program and the VIP bus. By May 2001, all seven packer garbage trucks in Yellowstone use B20 fuel. On June 14, 2001 a meeting at Old Faithful started the coordination 27 fleets in the region to use B20 in their roughly 700 vehicles and 1.3 million gallons of diesel fuel. On June 18, 2001 the Town Council of Jackson, Wyoming, voted to use B20 in their bus fleet at least during the summer months. The fleet manager of many of the surrounding national forests (Bridger-Teton, Caribou-Targhee, Salmon-Challis) has converted their 150 vehicle diesel fleet to B20. Xanterrra Parks and Resorts, Inc, the largest concessionaire in Yellowstone, is using their Yellowstone activities to determine if they will use biodiesel nation-wide at their other park operations. Other private fleets are considering use of B-20 in the summer 2003.

Awards:
U. S. Environmental Protection Agency EPA Region VIII. Outstanding Achievement Award to DEQ for Teamwork and Environmental Stewardship in Yellowstone Nation Park as exemplified by the Snowmobile and Truck in the Park Teams, August 27, 1996.
National Park Foundation 2001 National Park Partnership Award Honorable Mention for Environmental Conservation, April 22, 2001, Washington, D. C.

Reports, Papers, Other:

Biel, M. J., H. E. Hoekstra, and K. A. Gunther. November 1995. **Bear Attractant Test of Alternate Fuel Rapeseed Ethyl Ester**. Bear Management Office, Yellowstone Center for Resources, National Park Service. Yellowstone National Park, Wyoming.

Haines, H. August 18, 1995. **Status Report on the Truck in the Park Demonstration Project**. Montana Department of Environmental Quality, Helena, Montana.

Haines, H., and J. Evanoff. December 8, 1998. Environmental and Regulatory Benefits Derived from the Truck in the Park Biodiesel Emissions Testing and Demonstration in Yellowstone National Park. Montana Department of Environmental Quality. Helena, Montana
http://www.deq.state.mt.us/ppa/p2/bioenergy/truck_in_the_park_biodiesel_demo.asp
http://www.nps.gov/renew/yellbio.htm ,
http://www.deq.state.mt.us/ppa/p2/bioenergy/green_energy_parks_program.asp
http://www.deq.state.mt.us/ppa/p2/bioenergy/index.asp

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Kado, N. Y., P. A. Kuzmicky, R. A. Okamtot, and T. L. Huang. June, 1998. Bioassy and Chemical Analyses of the Emissions from Rapeseed Ethyl and Methyl Ester Biodiesel Fuels. EDG-95-7561. Department of Environmental Toxicology, University of California, Davis, California, and Montana Department of Environmental Quality. Helena, Montana

Kado, N. Y., P. A. Kuzmicky, R. A. Okamtot, and T. L. Huang. June, 1998. **Bioassy and Chemical Analyses of the Emissions from Rapeseed Ethyl and Methyl Ester Biodiesel Fuels**. Final Report, EDG-95-7561. Department of Environmental Toxicology, University of California, Davis, California, and Montana Department of Environmental Quality. Helena, Montana.

Peterson, C., S. Beck, C. Chase, H. Haines, D. Reece, and J. Thompson. August 22, 1995. **Producing biodiesel for the "Truck in the Park" Project.** Biomass Conference of the Americas, Portland, Oregon.

Peterson, C., C. Chase, H. Haines, D. Reece. October 16, 1995. **Emissions Testing at LA-MTA for the Truck in the Park" Project: Interim Report EDG-95-7562, TiPP.106.10.** Montana Department of Environmental Quality. Helena, Montana.

Peterson, C., C. Chase, H. Haines, D. Reece. November 1995. Emissions Testing with Blends of Esters of Rapeseed Oil Fuel With and Without a Catalytic Converter: Interim Report EDG-95-7562, TiPP.106.10. Montana Department of Environmental Quality. Helena, Montana.

Peterson, Charles L., University of Idaho, and Howard E. Haines, Montana Department of Environmental Quality. August 1999. Truck-in-the-Park Biodiesel Demonstration with Yellowstone National Park Final Technical Report. DNRC #EDG-95-7562 (R/C6832), US DOE # DE-FG51-94R020493, DEQ #780006 (O/U#2306).

Sharp, C. A., H. E. Haines. November 1996. **Emissions and Lubricants Evaluation of Rapeseed Derived Biodiesel Fuels.** EDG-93-7549, SwRI 7507. Montana Department of Environmental Quality. Helena, Montana.

Taberski, Jeffrey S, C. L. Peterson, and H. E. Haines. October 1998. Emission Analysis from Chassis Dynamometer Tests of the "Truck-in-the-Park" Project. Bioenergy '98 Conference. Madison, Wisconsin.

Taberski, Jeffrey S. January 1999. Performance, Durability, and Emissions of 100 Percent Canola Ethyl Ester Biodiesel for an Environmentally Sensitive Application. College of Graduate Studies, University of Idaho, Moscow, Idaho.

Taberski, J. S., Peterson, C. L., Thompson, J., and Haines, H. E.. September 1999. Using Biodiesel in Yellowstone National Park – Final Report of the Truck in the Park Project.. SAE 1999-01-2798, New Diesel Engines, Components, and Cooling Systems, International Off-Highway and Powerplant Congress and Exposition, Indianapolis, Indiana. Society of Automotive Engineers, Warrendale Pennsylvania.

13. Future Activities: Text and photos for a brochure depicting the most important findings has been drafted, and will be used to add to the demonstration and a guide for the permanent historic vehicle display. An informational "time capsule" will be developed and added with the truck as it goes into Yellowstone's historic vehicle collection.

14. Date Prepared: December 15, 1994
15. Date Amended: February 22, 2006
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